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ABSTRACT

This study considered the effects of gender and cognitive processing capacity on achievement of students at an intermediate school. The capacity test developed by J. M. Furukawa (1970, 1977), which requires examinees to recall word pairs immediately after a brief exposure, was modified for use with these students. The test was adopted because it is the basis for a "CPC" model of teaching and learning that has been shown to improve achievement of college students. The model asks students to personalize learning by processing units of information in quantities that match their capacities (C) from a pyramid (P) of knowledge or a study outline with a base of relatively simple concepts or stimuli and a superordinate concept that subsumes the others. Students are asked to chunk (C) these concepts into a meaningful whole. The field study involved 236 students, half of whom learned the CPC approach in grade 6. When the students were taught this way of adjusting learning to capacity, scores on academic skills measured by the Stanford tests increased, and this increase reduced the advantage shown by girls in the nonCPC group. The CPC approach served as an equalizer for lower capacity males and females by highlighting key information for mastery. Implications for instruction in the intermediate grades are discussed. One appendix presents the capacity test and the other gives two teaching examples. (Contains 1 figure, 1 table, and 10 references.) (SLD)

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Gender and Capacity Effects on Achievement Before and After CPC Way of Individualizing Learning

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Summary

Gender and Capacity Effects on Achievement: Before and After the CPC Way of Individualizing Learning

This investigation considered the effects of gender and cognitive processing capacity (capacity) on achievement at an intermediate school. Findings on gender effects revealed that females surpassed males in perceptual skills and language-related skills such as writing (Hedges & Nowell, 1995). Males, on the other hand, surpassed females in mathematics. However, a preliminary investigation at the intermediate school found girls to be superior to boys in both reading and mathematics on the Stanford Achievement Test (Stanford).

The capacity test (Furukawa 1970, 1977), which requires persons to recall word pairs immediately after a brief exposure, was modified for use at the intermediate school (Appendix A). The test was adopted because it is the basis of a CPC model of teaching and learning that improved college achievement by adjusting learning to capacity differences (Furukawa, Cohen, & Sumpter, 1982). It was assumed that if the CPC model worked for college students, then it should do the same for intermediate school students. That is, it should halt the annually declining Stanford scores. The earlier mentioned preliminary investigation provided some support for such an assumption, for the capacity test showed that girls had significantly higher capacities than boys, and higher capacity students—irrespective of gender—surpassed lower capacity students on the Stanford. Essentially, the CPC model asks students to personalize learning by processing units of information (a) in quantities that match their capacities (C);

(b) from a pyramid (P) of knowledge or study outline, with a base of relatively simple stimuli or concepts ascending to an apex with a superordinate concept capable of subsuming all subordinate concepts; and (c) by chunking (C) (verbally integrating or pictorially consolidating) them into a single, meaningful whole for application in appropriate situations (Furukawa et al., 1982) (see Appendix B for two brief teaching examples).

The model conforms to Snow's (1986) suggestion that the way to improve student achievement is to understand individual differences (gender and capacity in the present study) among students and "to connect them directly to the design of adaptive educational systems, teacher training programs, and diagnostic assessment devices" (p. 1037). On the whole, however, aptitude-treatment research has not been very fruitful (Tobias, 1989). In fact, Tobias quoted Cronbach and Snow's (1977) conclusion that "no aptitude treatment interactions are so well confirmed that they can be used directly as guides to instruction" (p. 492).

The field study involved 236 students—118 in each of two groups: One group learned the CPC Way in sixth grade (CPC students) and the second group did not (Non-CPC students). The findings revealed that, when entering sixth graders were taught how to adjust learning to capacity, at the end of eighth grade, scores on all academic skills measured by the Stanford increased a statistically significant average of 6.15 points (Table). These results were reported elsewhere (Furukawa, 1996). For gender and capacity comparison reported here, however, 160 students (40 boys and 40 girls in CPC and Non-CPC groups) were matched

by gender and CPC.

The results of the reanalyses revealed an overall increase of 9.66 normal curve equivalent points in Stanford scores from Non-CPC to CPC treatments, with girls increasing by 8.41 and boys by 10.90. Nevertheless, performance seems to have peaked in the seventh grade. While the girls scored significantly higher than boys in the Non-CPC group, t (13), 3.74, $p<.00$, the performance-enhancing effect of the CPC Way reduced the girls advantage to a non-significant one for the CPC group. Girls seemed to be less influenced by capacity differences (lower correlations between capacity scores and Stanford scores), especially after learning the CPC Way. Consequently, in terms of placing members in the upper 10% of the Stanford, they did so more frequently and required less capacity than boys in the CPC condition but not in the Non-CPC condition. However, there is some performance ambiguity involved in that girls in the CPC group scored highest in mathematics computation, but boys in the non-CPC group surpassed girls in mathematics computation (cf., Feingold, 1988). Additionally, when analyzing the performance of high-capacity students (>6.75), males surpassed females in practically all academic skills.

Despite these findings, none of the gender F ratios were significant in 3 X 2 (capacity categories high, middle, and low X girls and boys) analysis of variance. For the Non-CPC group, all F ratios for capacity were robust and significant. For the CPC group, however, the favorable effect of the CPC model limited significant capacity differences to three academic skills: total reading, social science, and listening.

Irrespective of gender, there is probably little doubt that a higher capacity is advantageous. Despite this advantage, the CPC Way assisted everyone, particularly the low-capacity students. As a result, the CPC Way serves as an equalizer for the lower capacity males and females by highlighting key information for mastery in quantities that match their personal capacities. Because of the small number of participants, especially low-capacity students, the findings should be interpreted with caution.

Three findings of this field study has significant educational implications.

(1) Capacity test. Since capacity has a direct and strong effect on learning, the test should be administered routinely in all classes, with students and teachers using capacity as a guide in learning and teaching, respectively.

(2) CPC Way. The strong, positive effect that the CPC Way had on achievement of all students suggests that it warrants widespread adoption to improve achievement. In addition to its effectiveness, its simplicity of use also enhances its value.

(3) Cost. Minimal costs and training requirements further increase the appeal of the CPC Way. It is primarily a way of rethinking our notions of the "fast" and "slow" learner and adjusting the learning environment to these notions for individualizing information processing.

For future replications, teachers at the intermediate school involved should consider increasing the use of the CPC Way in teaching. Also, they should consider surveying the latter part of the seventh and the entire eighth grade

curriculum to identify causes of the performance decrease from the seventh to the eighth grade. If there is a difference between what is taught and what is tested by the Stanford, then a decision has to be made as to what contents are of greater value to students. Students, in turn, should review the CPC Way at the beginning of the seventh and eighth grades and continue to follow models provided by teachers throughout the year to reap additional dividends. For both teachers and students, reaching a level of greater proficiency in the use of the CPC Way should lead to even higher achievement.

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Appendix A. Intermediate School Capacity Test

ADMINISTRATION

DIRECTIONS. On the pages to follow, you will find two forms of the capacity test. Each form is composed of two lists of word pairs, such as "hot day." These lists may be made into overhead transparencies or pages in a printed booklet, with a cover sheet and a blank page separating the two lists.

When administering the test, give your students one minute to study each list and two minutes to write down what they remember after each list.

When writing, if they can remember only one of the two words, have them write it like this: either "--- day" or "hot ---." The word pairs should be together, as in "hot day." However, they do not have to be written in the order in which they appeared on the list. In other words, students can write down the words in the order recalled.

TEST SUMMARY

List 1. Learning time: 1 minute.
Writing time: 2 minutes.
List 2. Same as above.

All students should have a pen or a pencil and a sheet of paper if the lists are being shown by an overhead projector. Also, the test should be administered in a quiet room.

If there is any reason to believe that a student may have been ill or otherwise unfit during the administration of a test, a second form (Form B) of the test should be administered. Never administer the same form of the test unless a year or more has elapsed since its last administration.

Form A: List One

warm puppy	clear desk
soft pencil	corner picture
young rider	tough lion
early spring	bald eagle
huge bean	brave guest
gentle pony	huge cabin
purple giant	great guide
metal floor	warm winter
dirty bear	baby sister
cloudy morning	storm watch

Form A: List Two

fair face	early morning
every school	many nights
cool water	deep pond
big bus	small boats
loud noise	blue sky
white paper	black shoes
dark hair	red wolf
large number	high mountain
powerful man	pretty girl
many friends	sick dog

Form B: List One

big foot	alcohol problem
red ball	floppy ears
fat bear	first time
rainy day	mountain peaks
bird songs	waking dream
wicked witch	kind deeds
summer camp	dirt roads
front wheels	sleeping bag
good example	knight's armor
sharp picture	funny clown

Form B: List Two

skinny legs	big bat
powerful jaws	heavy weight
fishing equipment	silly dog
every secret	high rocks
early bird	little elves
strange look	broken promise
back street	steam shovel
word picture	thick fog
beautiful princess	first day
young man	major problem

SCORING DIRECTIONS

Check the answers by comparing them with the words on the lists.

Give the student one point for each correct word and two points for each correct word pair; for example, "warm puppy," is worth two points. The spellings need not be perfect. If the student said "warm pupy" instead of "warm puppy," credit should be given. Also, distinctions between plural and singular forms may be ignored.

Add the scores for each list (total possible on a list is 40 points). Then sum the scores for the two lists. For example, if 12 points is scored on list one and 10 on list two, the total is 22.

Finally, divided the sum by 4. The answer is the student's capacity score.

SAMPLE

List 1: 12
List 2: 10
Total: 22

The sum, 22, divided by 4 = 5.5. Rounded off to the closest whole number, the student's memory capacity score is 6.

Appendix B. Two Teaching Examples

Here is a simple application of the CPC system in teaching letters of the alphabet. A kindergarten child has a capacity of approximately three. Therefore, the pyramid of knowledge has a base of prerequisite knowledge consisting of shapes and sounds and the animal, fox (Figure 1).

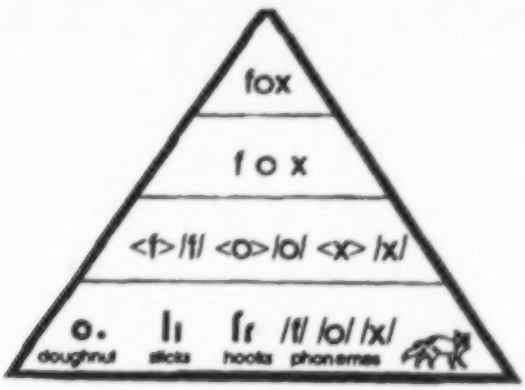

Figure 1. Fox-Dog pyramid.

Above it are three sounds (f, o, eks), three shapes (f, o, x), three letters (f, o, x), and one word (fox). The children learn the shapes through a matching task, the sounds by aping the teacher, three letters by combining the shapes and sounds, and finally, a word by combining the letters. From this initial lesson, in 17 days, kindergartners should master all of the letters of the alphabet and should read, "The fox is quick. That fox is brown. It jumps over my big lazy dog." Concurrently, in math, they should learn to solve simple addition and subtraction problems.

A more complex pyramid is shown in Figure 2. Fourth grade and older students use this

I. CPC Method of Teaching/Studying
  A. Capacity
    1. CPC
      a. things
      b. terms
        (1) bit
        (2) chunks
        (3) units
    2. chunks
    3. units
    4. young children
  B. Pyramid of Knowledge (omitted)
  C. Chunking (omitted)

Figure 2. Pyramid of knowledge.

type of pyramid that consists primarily of nouns and adjective-noun pairs. It permits learners to count the number of units of information until they match their capacities and to chunk them into a single, meaningful whole. By chunking, an entire book can become a single, massive chunk of information, with all information available for later recall and use in appropriate situations.

Table

Increases in Academic Skills

Academic Skills	CPC	Non-CPC	Increase*
Reading Comprehension	50.10	43.36	6.74
Reading Vocabulary	50.28	44.36	5.92
Total Reading	48.29	41.96	6.31
Spelling	53.50	48.45	5.05
Total Language	55.11	50.73	4.38
Science	51.64	45.67	5.97
Social Science	49.36	45.31	4.05
Mathematics Applications	55.17	50.41	4.76
Mathematics Computation	61.08	56.39	4.69
Concepts of Number	54.73	49.39	5.34
Total Mathematics	58.46	52.67	5.79
Using Information	54.92	46.49	8.43
Listening	48.76	39.09	9.67
Study Skills	55.21	46.18	9.03
Average Increase			**6.15**

Note. The largest increases were in listening and in using information and the smallest increase was in social science. Nevertheless, the highest average score for CPC students was in mathematics computation, and the lowest average scores (below 50) were in listening, social science, and total reading.

*$p<.001$